RDT

Brief

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3-D Computer Modeling of Subsurface Conditions for Bridge Foundations

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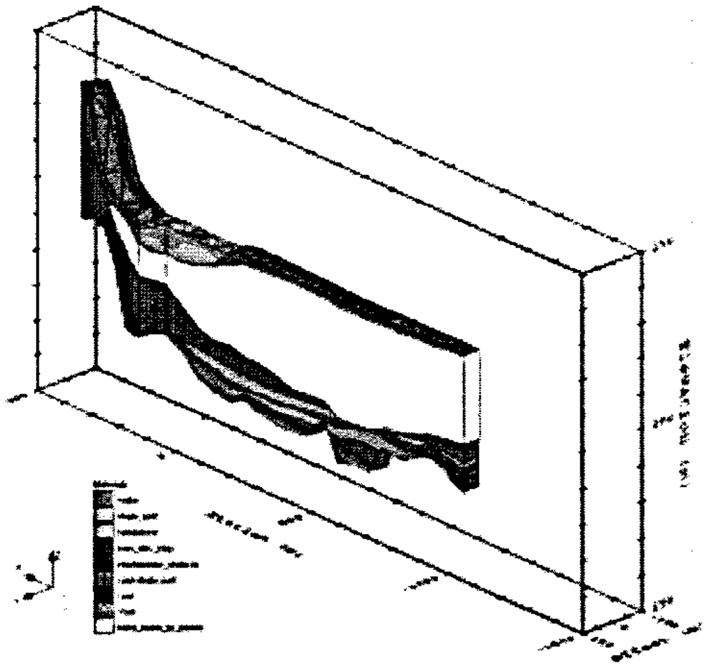
Successful design of bridge foundations requires fundamental and thorough understanding of the subsurface conditions at a bridge sites. Interpretation of subsurface conditions generally begins with geotechnical or geological personnel developing a "picture" of the site (mental or otherwise) based on available geologic information obtained from boring logs and other geological and geotechnical data. In the large majority of cases, this interpretation is a reasonable representation of site conditions considering the limitations inherent to geotechnical investigations. However, there is often difficulty in conveying the interpretation to other personnel due to the complexity of subsurface conditions present in even the simplest sites. Lack of a complete "picture" of subsurface conditions by all parties involved can lead to problems in both design and construction.

A study was conducted during the period of September 1999 to January 2000 to evaluate the potential for using three-dimensional computer models to assist MoDOT Soils and Geology personnel and Bridge Division personnel in developing accurate and realistic understanding of subsurface conditions for bridge structures. Secondary objectives of the study were to develop a preliminary procedure for development of three-dimensional geologic models and to identify key issues that need to be addressed for further development and implementation of three-dimensional modeling activities on a routine basis. The basic approach taken to meet project objectives was to develop several three-dimensional computer models of the subsurface conditions for the site of the proposed Lexington Bridge over the Missouri River on Route 13. The Lexington site was deemed a reasonable test case for demonstrating the potential benefits of three-dimensional modeling of subsurface conditions for bridge sites. While geologic conditions at the site are relatively straight forward, the site investigation activities for the project are indicative of those undertaken for more complex sites. The site thus served as a reasonable test of the ability to digitally store and display large amounts of data while limiting the difficulty with complex geological conditions.

Since it is not generally practical to develop a single, "all purpose" model, several different models were developed during the project to demonstration the range in model complexity and refinement that is possible for a particular site. Developed models include a simple soil-rock model for the entire site that might be used for construction cost estimates or constructability studies, a refined model of the river crossing area to emphasize a critical area of the structural foundations, and a refined

model of the entire site that represents a practical maximum degree of refinement that can be utilized for subsurface modeling. The refined model of the entire site is shown in the following figure.



The results of this project demonstrate that development of three-dimensional computer models of subsurface conditions for bridge sites can be an extremely effective means for describing key elements of subsurface profiles and conveying a visual picture of the subsurface. This, in turn, leads to improved understanding of subsurface conditions by all parties and can lead to identification of potential problem conditions before construction begins and identification of beneficial alternative designs. Three-dimensional modeling software also provides a number of direct benefits to geo-professionals developing an interpretation of the subsurface by facilitating management and display of large amounts of subsurface data that might otherwise be underutilized. This, in turn, assists with interpretation by highlighting locations where uncertainty about subsurface conditions is high; providing direct feedback on potentially conflicting boring logs; and identifying locations where additional subsurface investigation may be warranted. Thus, while three-dimensional models of subsurface conditions will be no better than the data on which they are based and the skill of the interpreter, the process of developing models can enhance understanding of subsurface conditions for all involved.

In addition to enhancing understanding of subsurface conditions, three-dimensional models can be used to model the construction sequence for a site including excavation and filling operations. The models can be used to evaluate design alternatives, to identify potential borrow sites, and for estimation of cut and fill quantities for cost estimation purposes. Geologic models could also be updated during construction as actual conditions are revealed to provide valuable information for subsequent construction activities or future design and maintenance operations.

Based on the results of this project, an expanded pilot program was recommended to further evaluate the potential for using three-dimensional computer models on a more extensive basis. The expanded pilot program is expected to include sites with increasing complexity. Subsequent modeling activities should employ historical geotechnical data from previous geotechnical investigations and models should be developed during site investigation operations to assist with selection of boring locations that will minimize the uncertainty associated with subsurface conditions. MoDOT is currently considering application of the expanded pilot program for three-dimensional modeling.

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